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(54) **ADJUSTABLE OPTICAL AXIS CONTROL**

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G03B 5/00 (2006.01)
G03B 17/56 (2006.01)
G02B 7/18 (2006.01)

(52) **U.S. Cl.**
CPC ***G03B 5/00*** (2013.01); ***G02B 7/1805*** (2013.01); ***G03B 17/565*** (2013.01)

(58) **Field of Classification Search**
USPC 396/544
See application file for complete search history.

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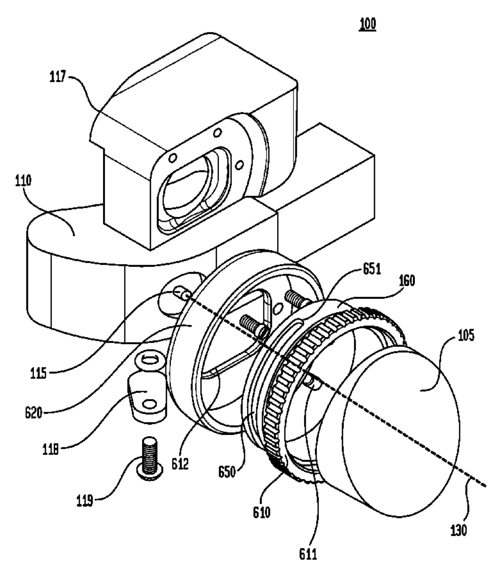
(57) **ABSTRACT**

A device for aligning the optical axis of a camera is disclosed. The optical alignment device comprises a bracket attaching the device to a frame, the frame incorporating a camera system therein, the camera system having an optical axis projecting substantially horizontally from the camera system, a housing comprising a first part fixed to a first side of the bracket; and a second part comprising a prism refracting the optical axis of the camera system based on a power of the prism and a rotation of the prism with respect to the optical axis and a hinge between the first part and the second part, the hinge rotating the second part with respect to the first part.

20 Claims, 16 Drawing Sheets



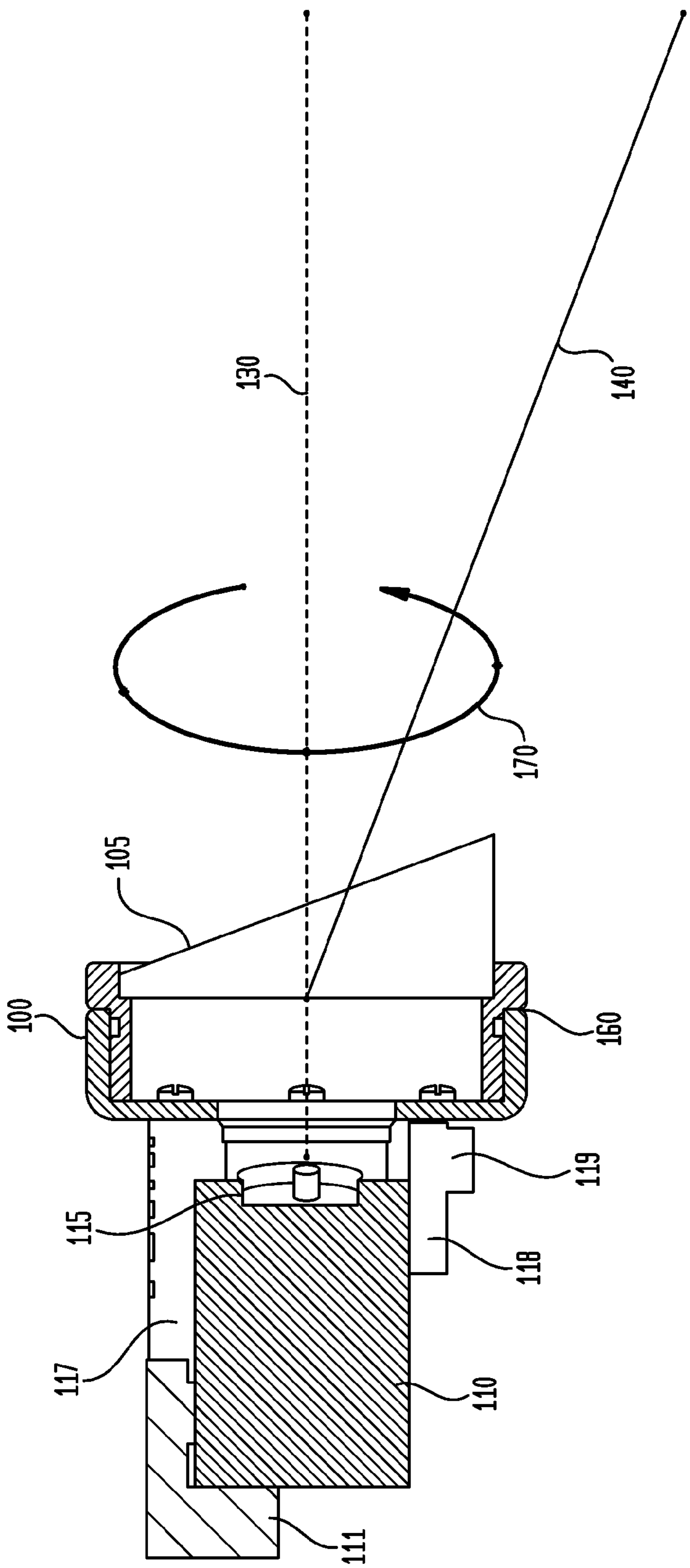
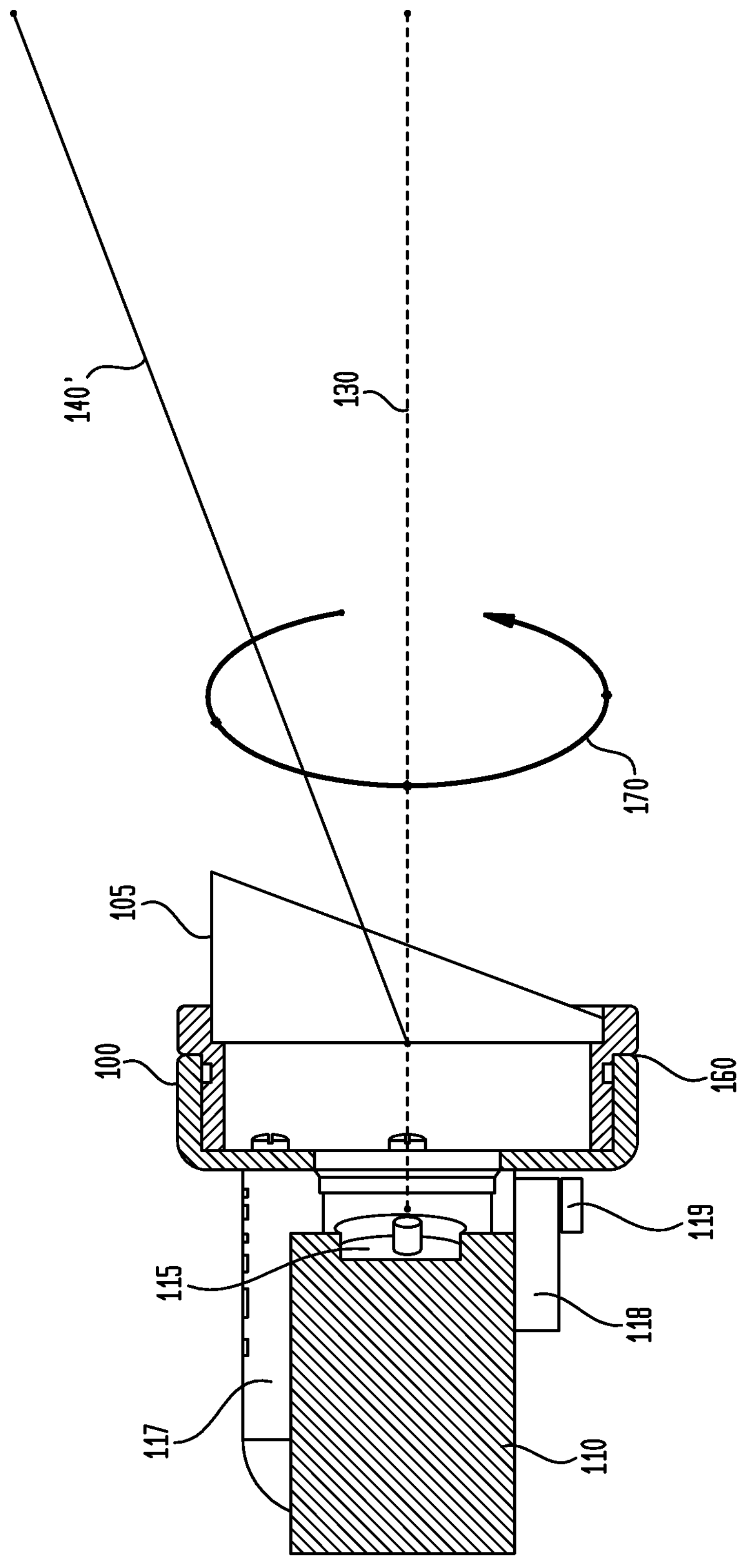


FIG. 1A

FIG. 1B



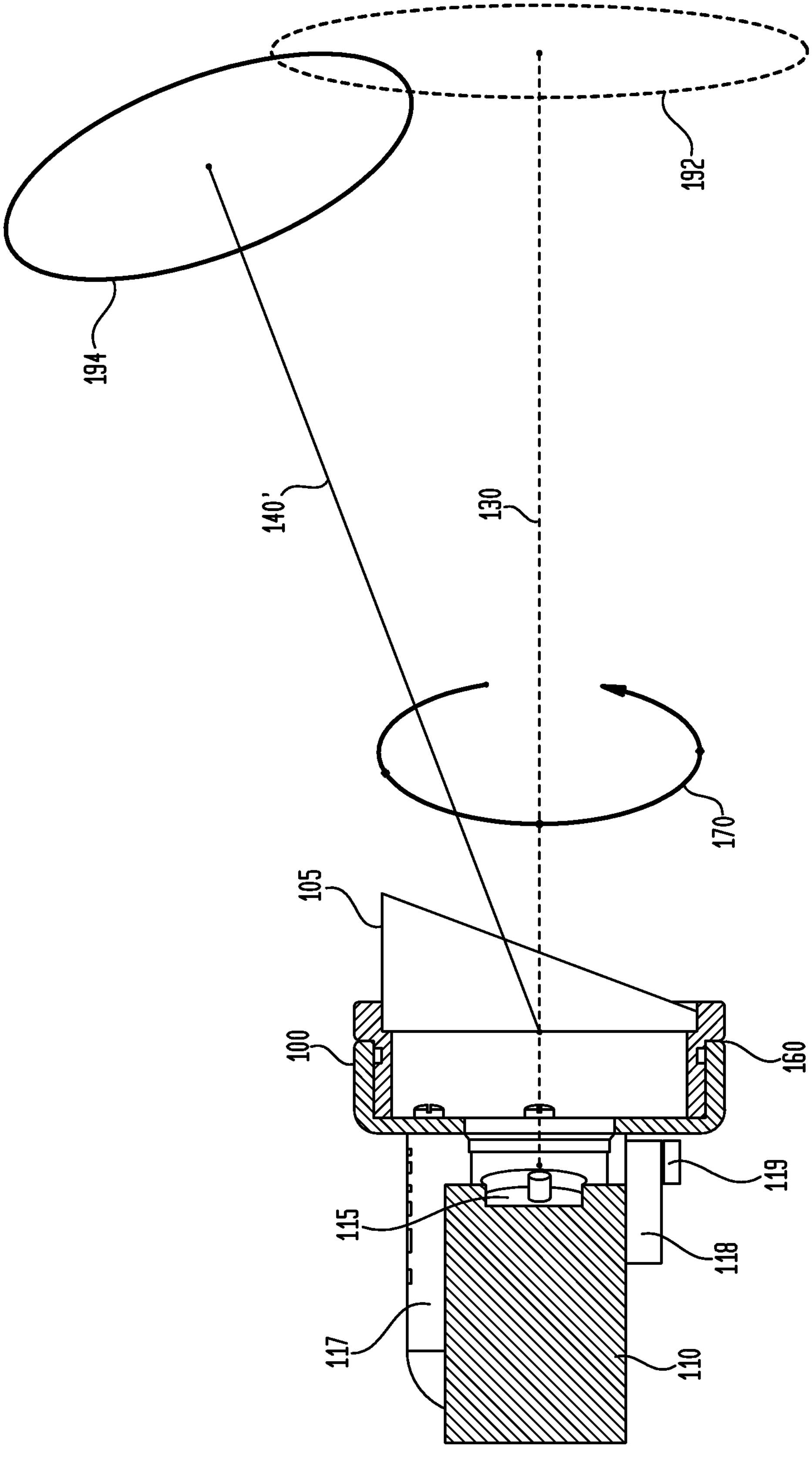


FIG. 1C

FIG. 2

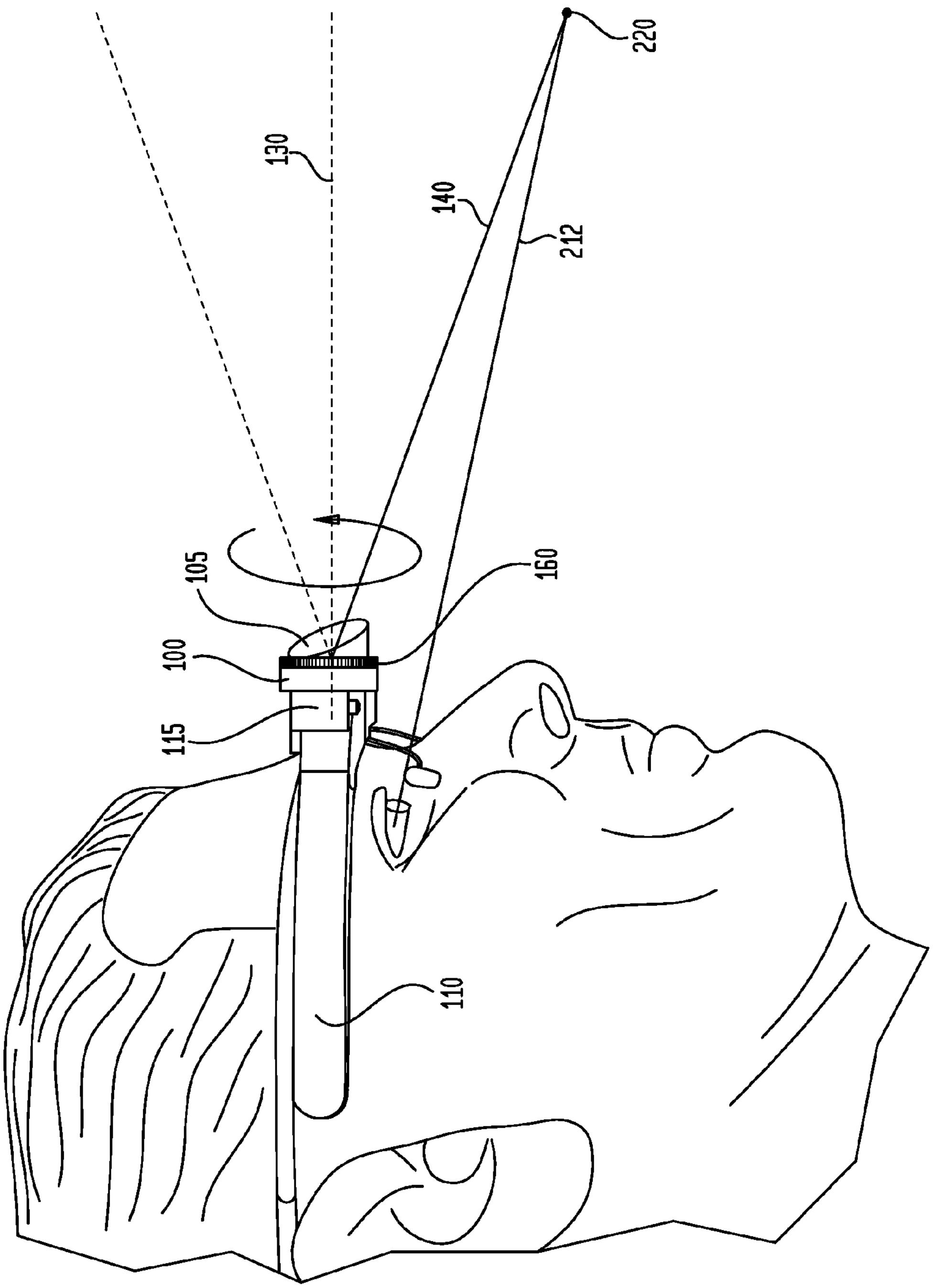


FIG. 3

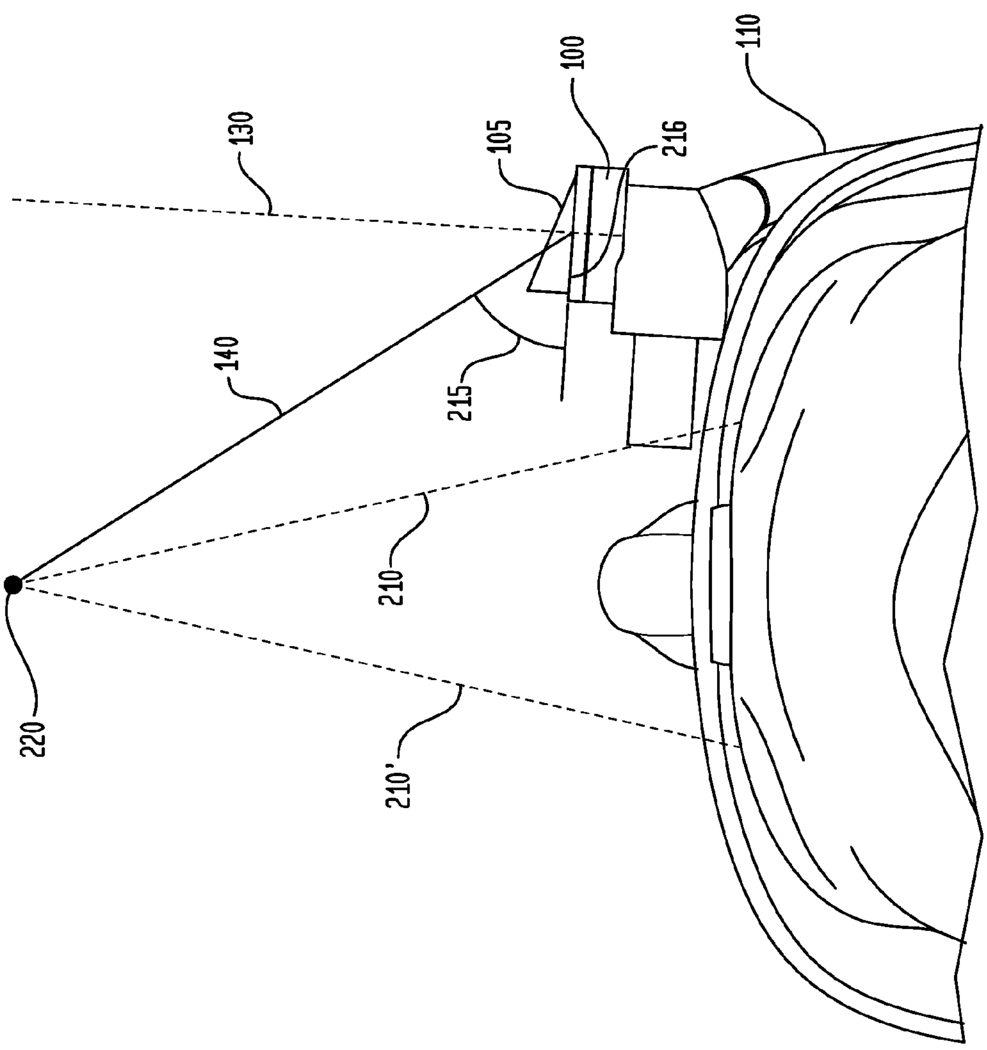


FIG. 4

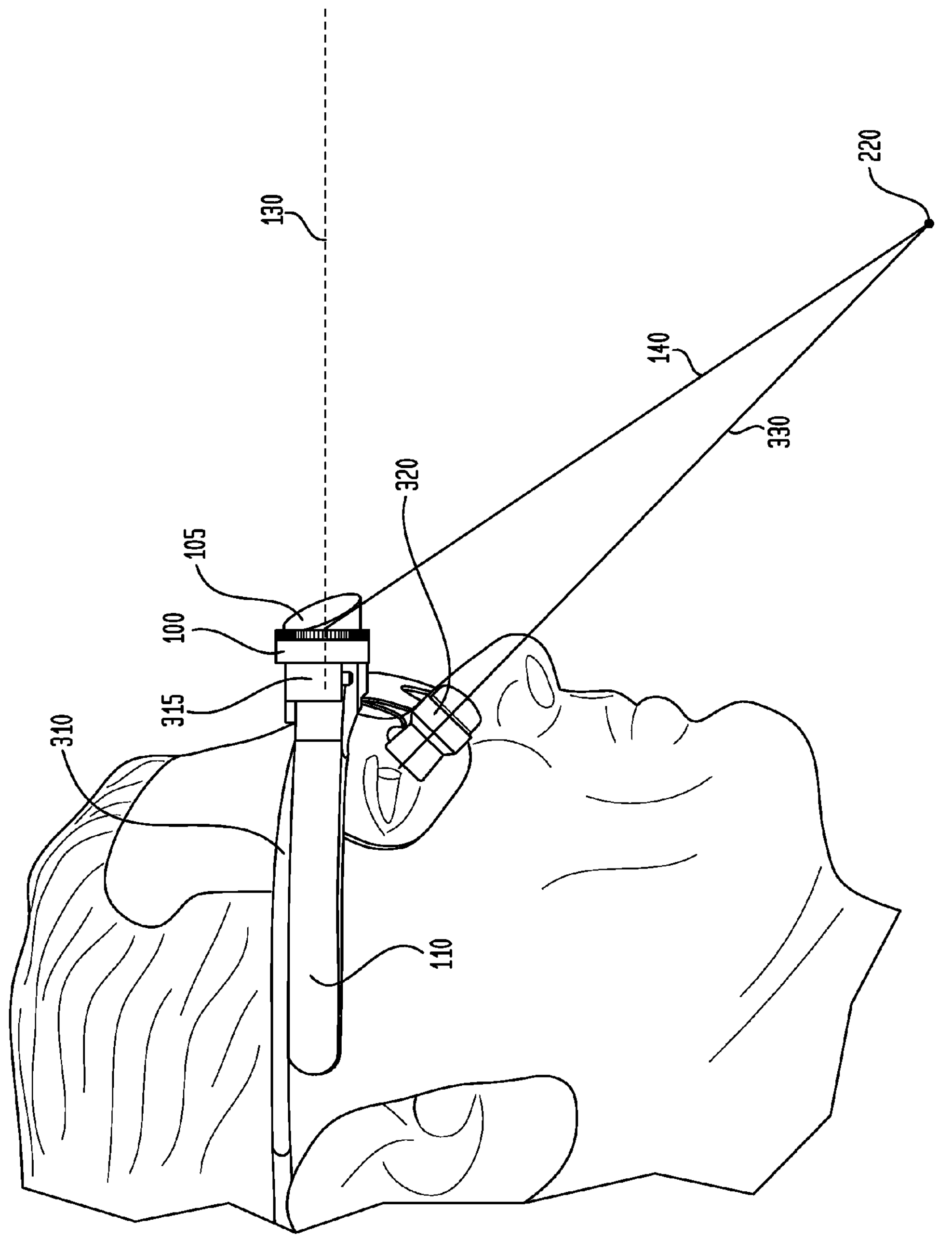
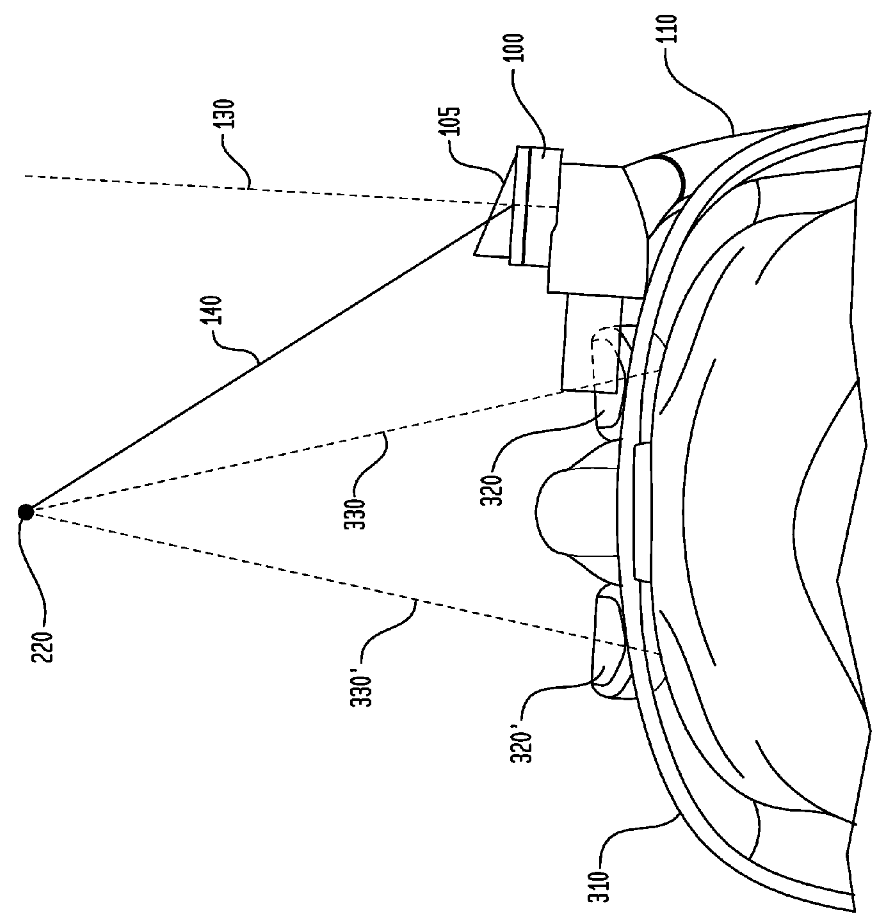


FIG. 5



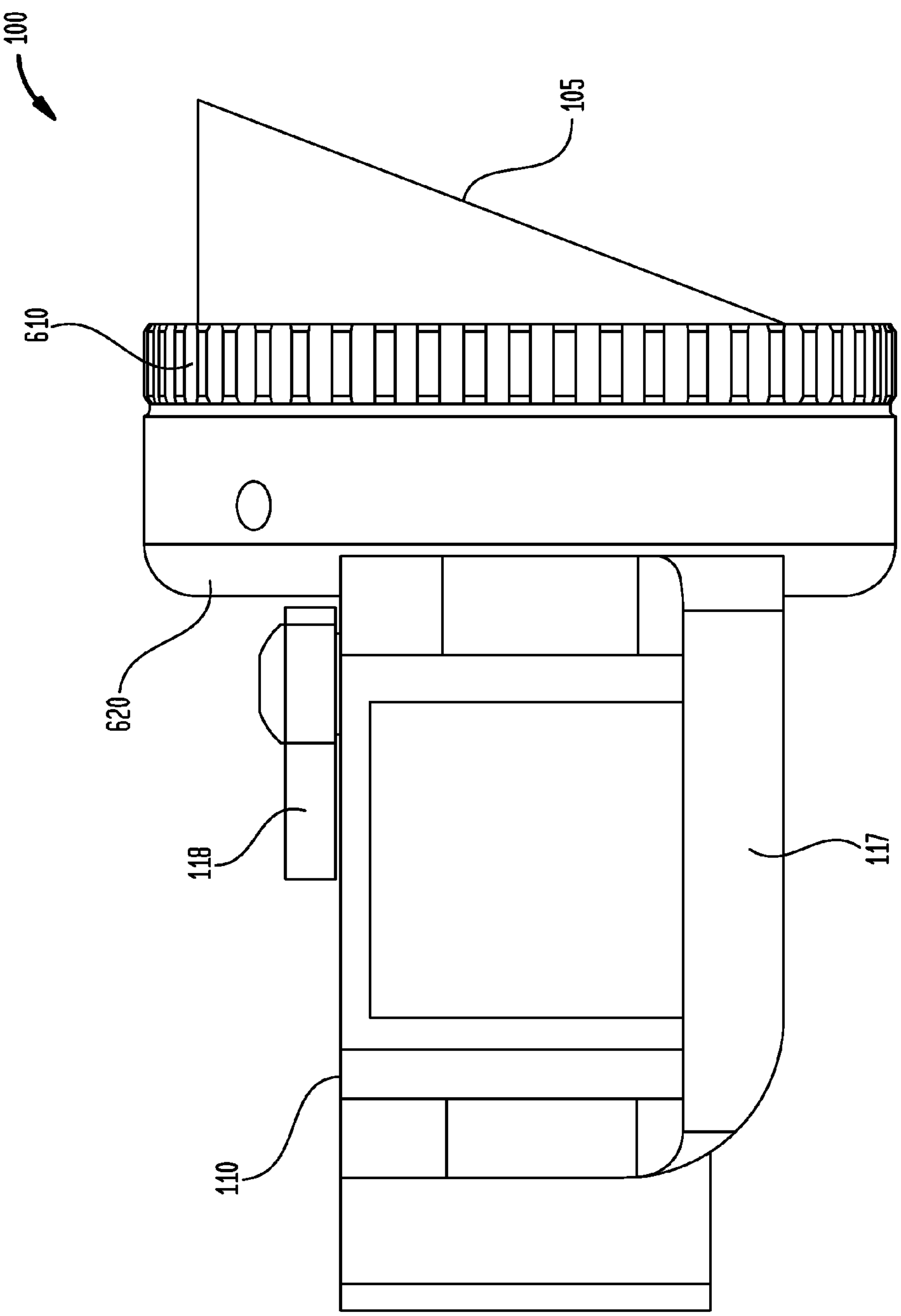
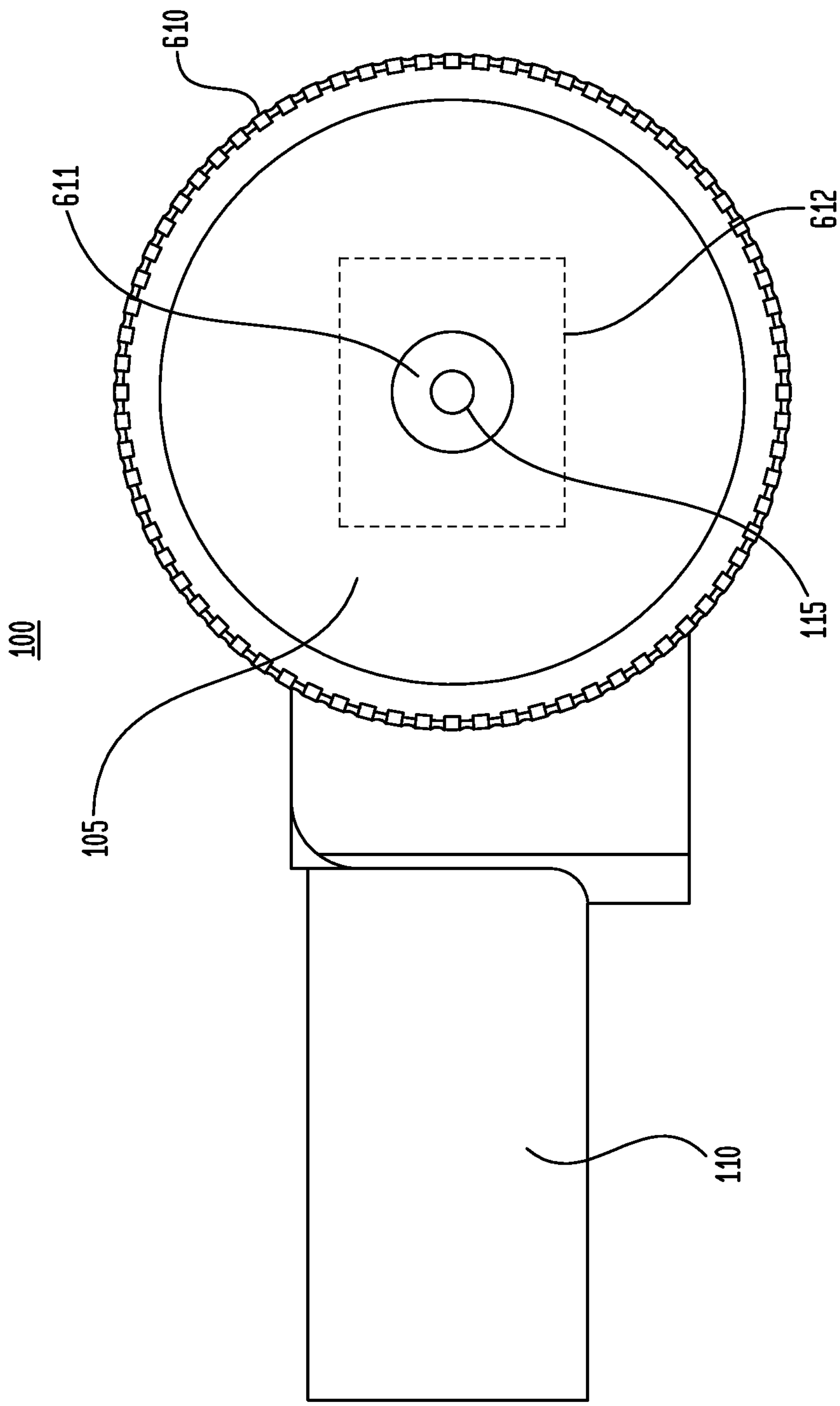


FIG. 6A

FIG. 6B



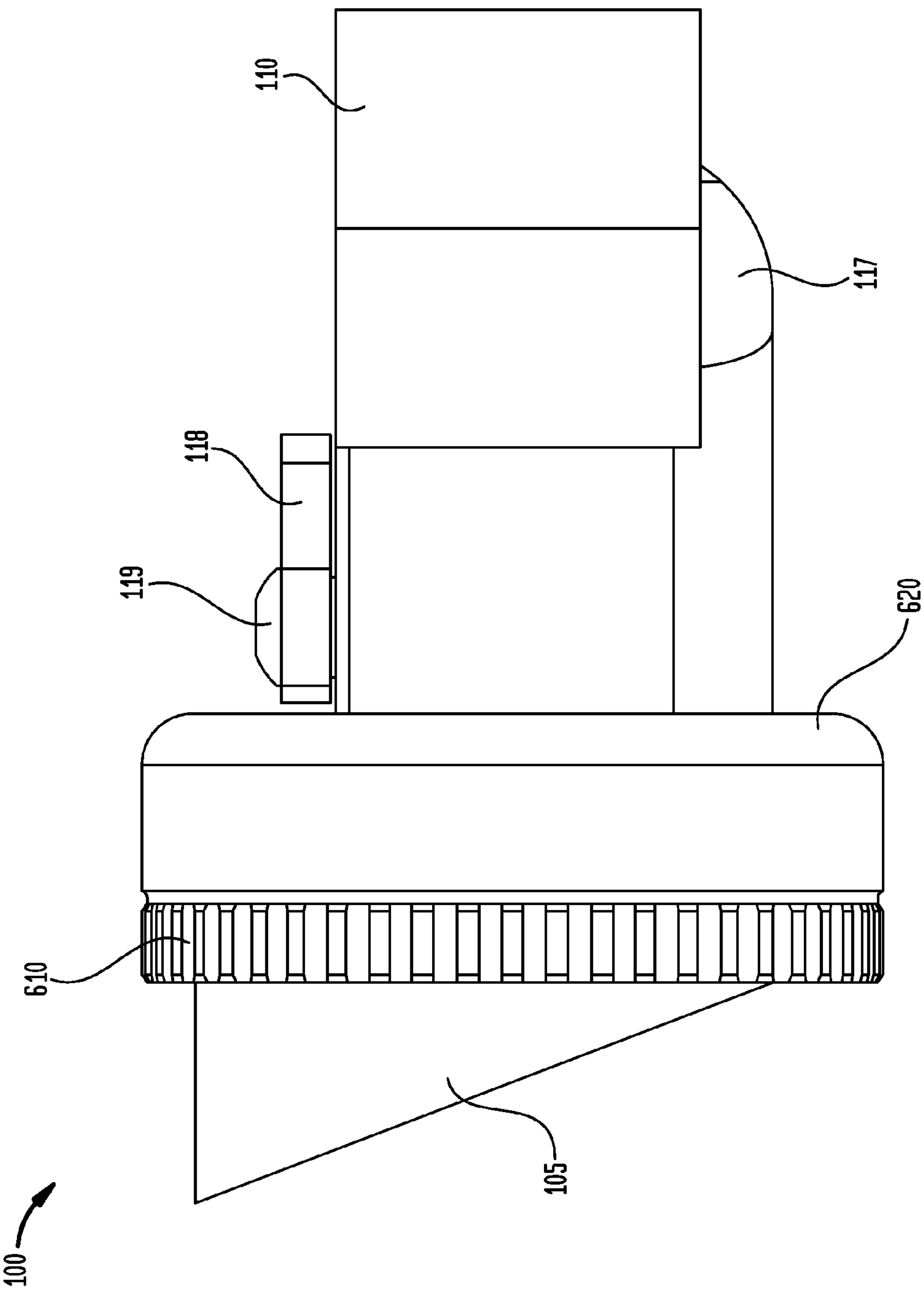


FIG. 6C

FIG. 6D

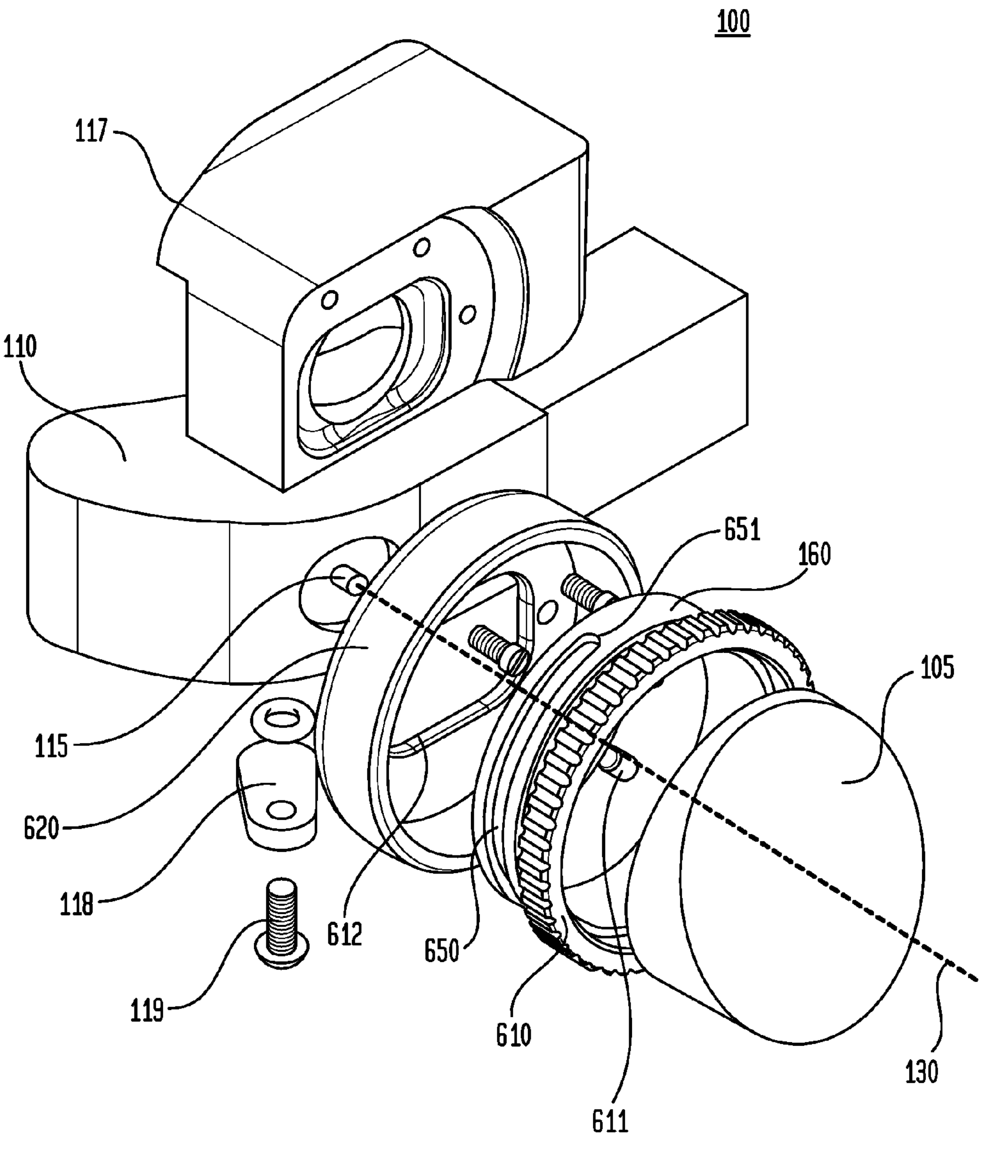


FIG. 7

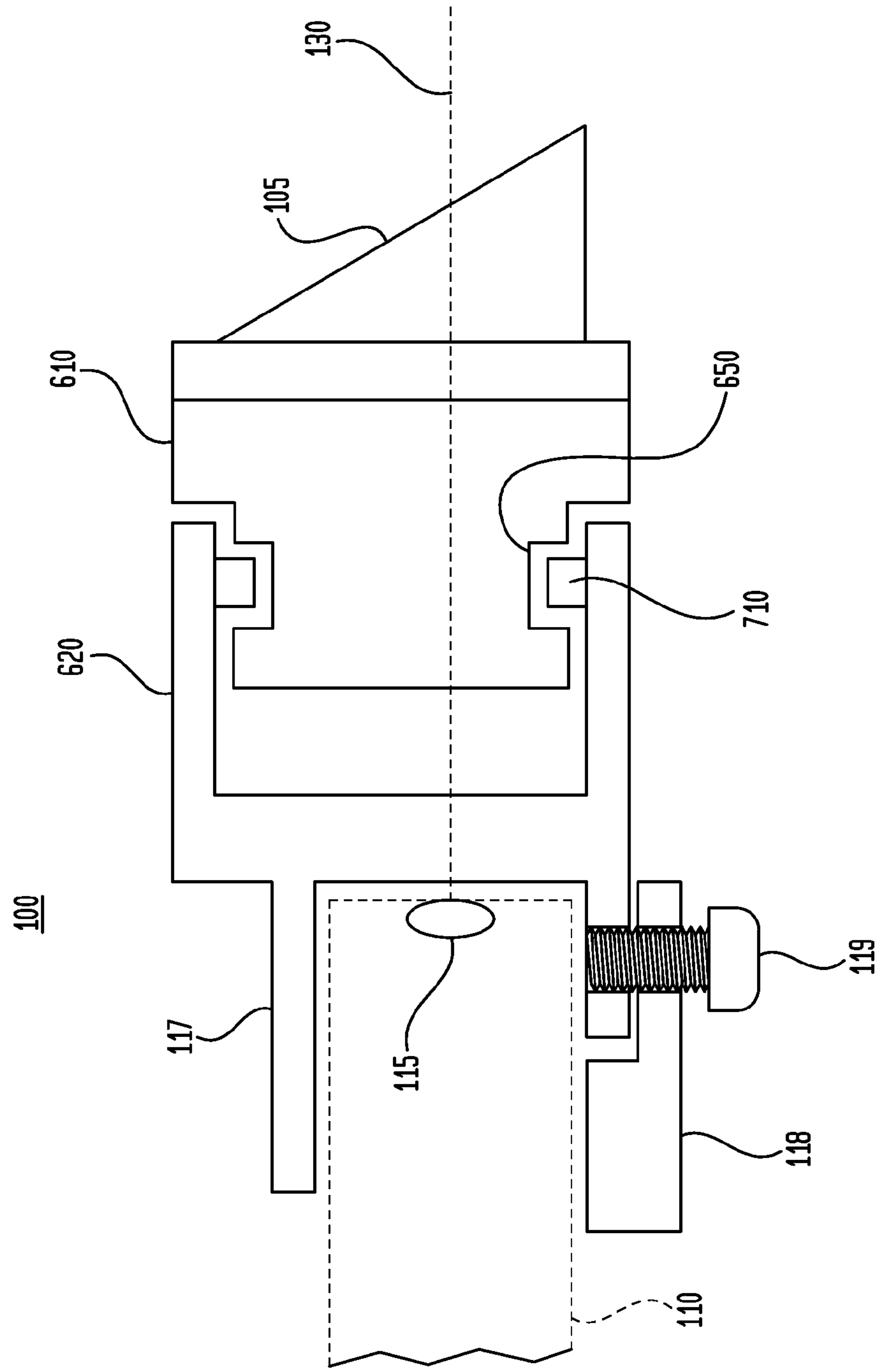


FIG. 8A

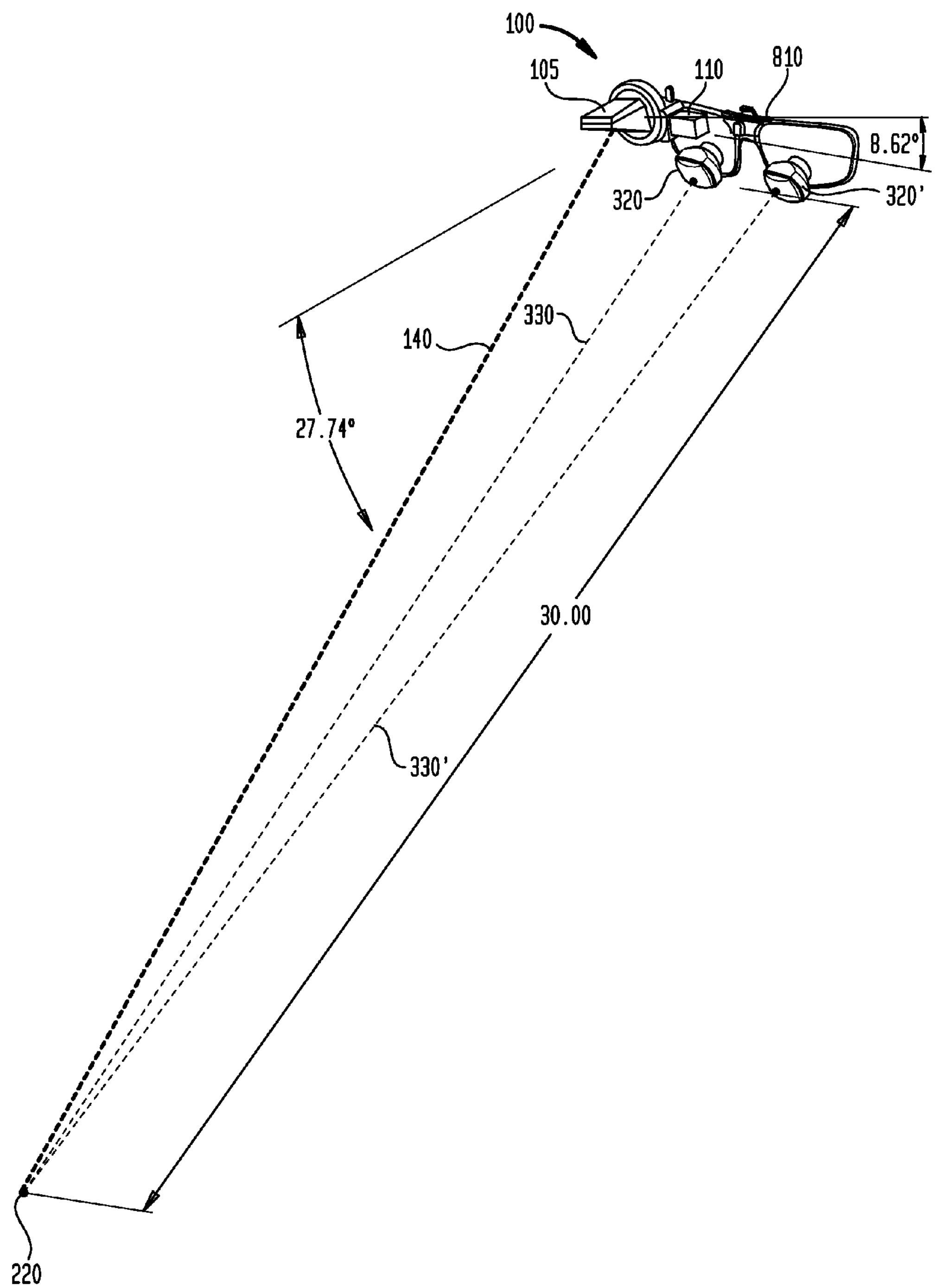


FIG. 8B

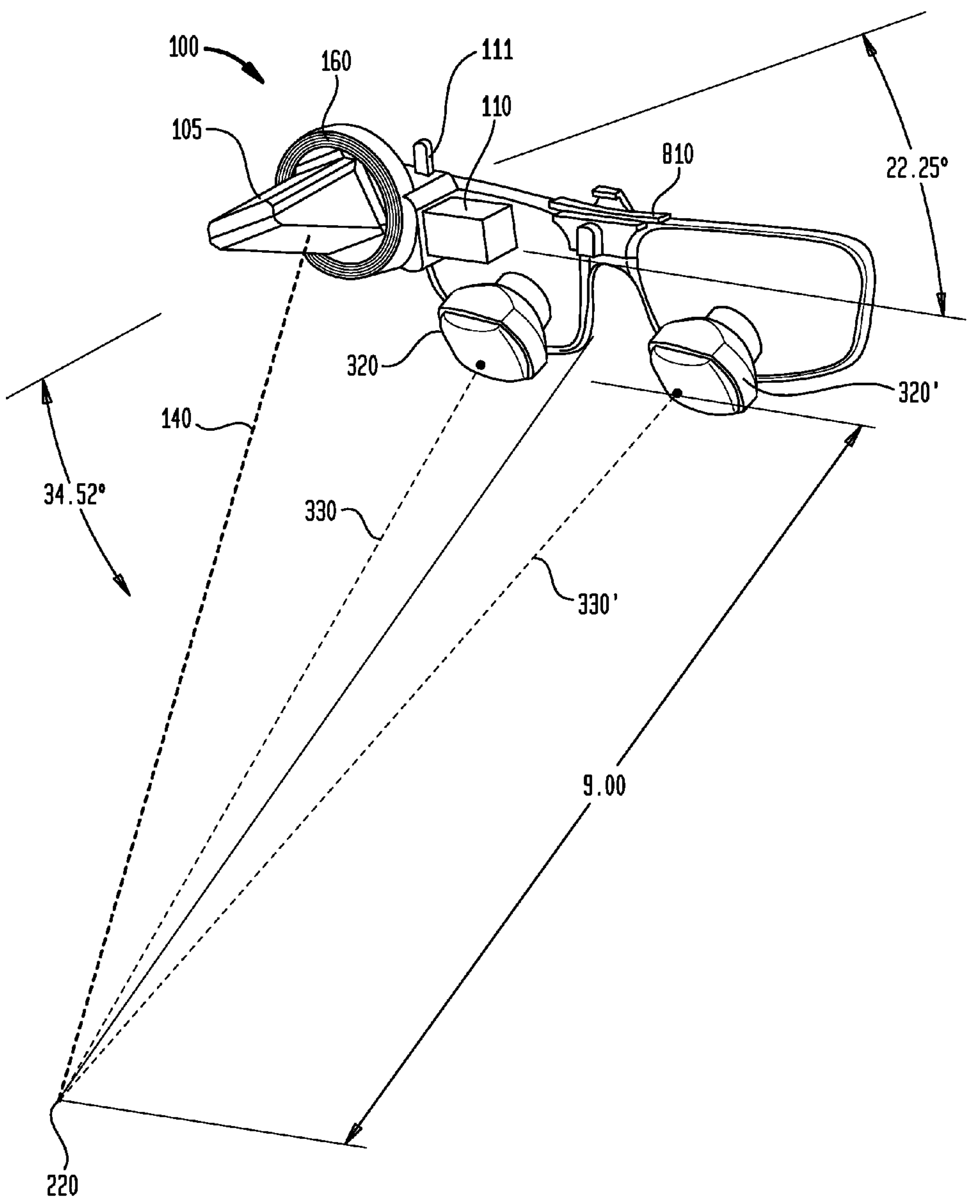
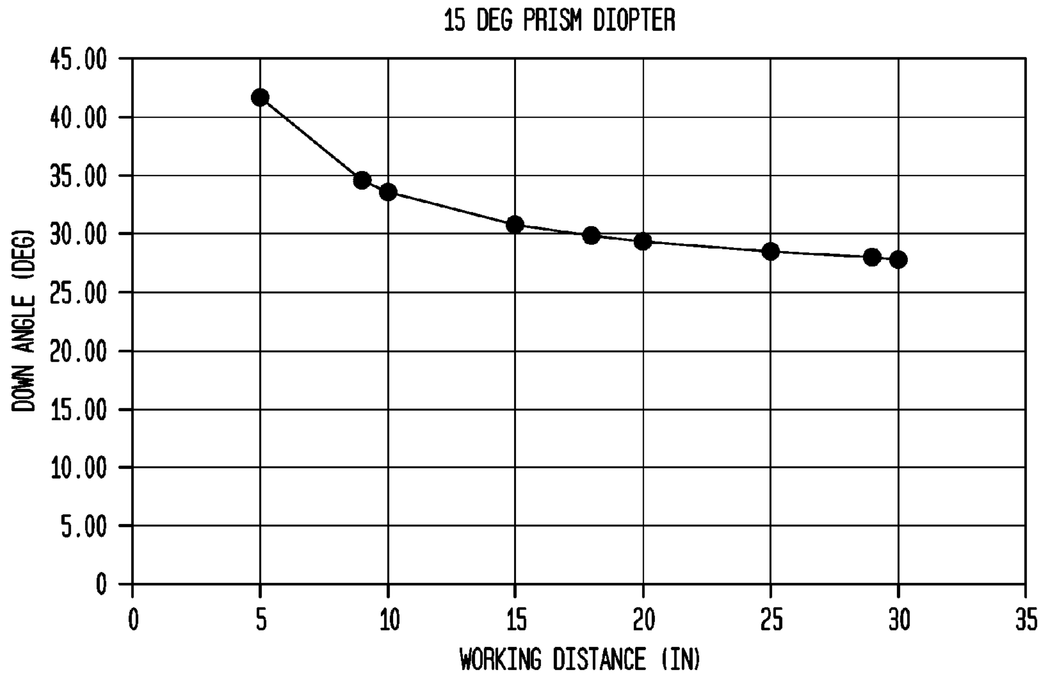


FIG. 9A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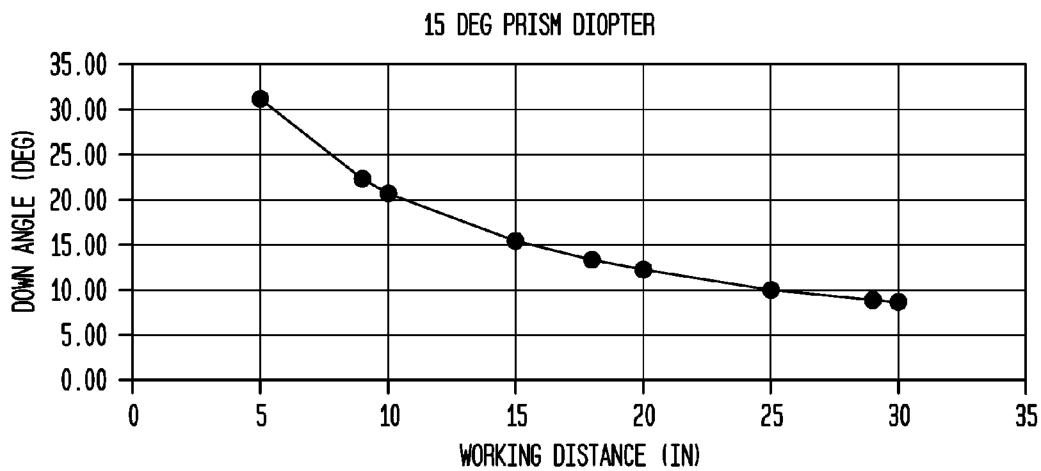
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0
DOWN ANGLE (DEG)
0
5
10
15
20
25
30
35
WORKING DISTANCE (IN)

FIG. 9B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10.00
5.00
0.00
DOWN ANGLE (DEG)
0
5
10
15
20
25
30
35
WORKING DISTANCE (IN)

FIG. 10

DRILL ANGLE (DEG) 25 DEG.	PRISM ANGLE (DEG) 15 DEG. PRISM DIOPTOR	
WORKING DISTANCE (IN)	ROTATION ANGLE FROM HORIZONTAL AXIS	DOWN ANGLE
5	31.2	41.68
9	22.3	34.52
10	20.7	33.58
15	15.4	30.76
18	13.3	29.81
20	12.2	29.33
25	10.1	28.47
29	8.9	27.99
30	8.6	27.74

ADJUSTABLE OPTICAL AXIS CONTROL

CLAIM OF PRIORITY

This application claims, pursuant to 35 USC 119, priority to, and the benefit of the earlier filing date of, that patent application entitled "Adjustable Optical Axis Control," filed on Jul. 24, 2014 and afforded Ser. No. 62/028,692, the contents of which are incorporated by reference, herein.

RELATED APPLICATION

This application is related to co-pending patent application entitled "System for Camera Viewing and Illumination Alignment," filed on Nov. 22, 2013 and afforded Ser. No. 14/087,322 and co-pending patent application entitled "System for Camera Viewing and Illumination Alignment," filed on May 17, 2014 and afforded Ser. No. 14/280,576, the contents each of which is incorporated in their entirety, by reference herein.

FIELD OF THE INVENTION

The instant application relates to the field of optics and more particularly to alignment of a camera axis to a desired viewing axis.

BACKGROUND OF THE INVENTION

GLASS, Google's head mounted device, represents a type of wearable technology that incorporates a digital camera into a head mounted device, such as a pair of glasses, which allows a user to perform task in a hands-free format. GLASS is a registered Trademark of Google, Inc., 160 Amphitheatre Parkway, Mountain View, Ca. The Google GLASS also has an integrated wide angle camera, which allows the wearer to take both video and images of scenes that are within the optical field of the wide angle camera. Utilizing the features of head mounted display and integrated camera, Google GLASS allows the wearer to capture events in real-time.

Generally, the optical axis of the Google GLASS is oriented substantially perpendicular to the mounting of GLASS to the frame. Such a configuration inhibits the optical axis from being independently directed. However, if the wearer is looking in a direction other than substantially perpendicular to the frame, the camera will not record what the wearer is looking at. Rather the camera will record what is substantially perpendicular to the frame. For example, if the user is looking in a downward direction in a task oriented position, e.g., cooking, writing, maintenance work, etc., the camera may or may not record what the wearer is looking at. As a result, users may not be able to orient the optical axis of the camera to intersect a user's viewing axis at a desired distance from the user.

Hence, there is a need in the industry for a method and system for orienting the optical axis of a camera system (e.g., Google GLASS camera) to intersect a user's viewing axis at a desired distance from the user.

SUMMARY OF THE INVENTION

A device for orienting an optical axis of a wide angle camera with a user's viewing axis at a desired distance from the user is disclosed.

The device comprises an attachment housing rotatable connected to a second housing. The second housing incorporating a prism assembly aligned with the optical axis of a wide

angle camera that provides for the refraction of the optical axis of the wide angle camera.

The second housing may have a fixing means to retain the second housing, and the orientation of the prism, to maintain the refracted optical axis of the wide angle camera.

A device for aligning the optical axis of a camera is disclosed. The optical alignment device comprises a bracket attaching the device to a frame, the frame incorporating a camera system therein, the camera system having an optical axis projecting substantially horizontally from the camera system, a housing comprising a first part fixed to a first side of the bracket; and a second part comprising a prism refracting the optical axis of the camera system based on a power of the prism and a rotation of the prism with respect to the optical axis and a hinge between the first part and the second part, the hinge rotating the second part with respect to the first part.

BRIEF DESCRIPTION OF THE FIGURES

For a better understanding of exemplary embodiments and to show how the same may be carried into effect, reference is made to the accompanying drawings. It is stressed that the particulars shown are by way of example only and for purposes of illustrative discussion of the preferred embodiments of the present disclosure, and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice. In the accompanying drawings:

FIG. **1**A illustrates an exemplary embodiment of a first orientation of an optical axis device control in accordance with the principles of the invention.

FIG. **1**B illustrates an exemplary embodiment of a second orientation of an optical axis control device in accordance with the principles of the invention.

FIG. **1**C illustrates further details of the second orientation of an optical axis control device in accordance with the principles of the invention.

FIG. **2** illustrates a side view of an application of an exemplary device for controlling an orientation of an optical axis of a wide angle camera in accordance with the principles of the invention.

FIG. **3** illustrates a top view of an application of an exemplary device for controlling an orientation of an optical axis of a wide angle camera in accordance with the principles of the invention.

FIG. **4** illustrates a side view of a second application of an exemplary device for controlling an orientation of an optical axis of a wide angle camera in accordance with the principles of the invention.

FIG. **5** illustrates a top view of the second application of the exemplary device for controlling an orientation of an optical axis of a wide angle camera in accordance with the principles of the invention.

FIGS. **6**A-**6**D illustrate perspective views of the optical axis orientation control device in accordance with the principles of the invention.

FIG. **7** illustrates a cross-section view of the optical axis orientation control device in accordance with the principles of the invention.

FIGS. **8**A-**8**B illustrates perspective views of an optical device in accordance with the principles of the invention.

FIGS. **9**A-**9**B illustrate graphs of an orientation of an optical device in accordance with the principles of the invention versus working distance.

FIG. **10** illustrates a table of orientation settings of an optical device in accordance with the principles of the invention versus working distance.

It is to be understood that the figures and descriptions of the present invention described herein have been simplified to illustrate the elements that are relevant for a clear understanding of the present invention, while eliminating, for purposes of clarity many other elements. However, because these omitted elements are well-known in the art, and because they do not facilitate a better understanding of the present invention, a discussion of such element is not provided herein. The disclosure herein is directed to also variations and modifications known to those skilled in the art.

DETAILED DESCRIPTION

FIG. **1**A Illustrates an exemplary optical axis control device **100** in accordance with the principles of the invention. In this illustrated example, control device **100** is attached to a wide angle lens camera system **110**. In one aspect of the invention, the wide angle lens camera system **110** may be the same or similar to that of the commonly referred to Google GLASS, that is currently available. In accordance with the principles of the invention, the focal point of camera system **110** is altered from the optical axis **130** shown to lie along the angle of refraction (e.g., **140**, **140'**) of prism **105**, as described in further detail herein.

Although the present invention is described with regard to the Google GLASS device, it would be appreciated that the present invention may be applicable to any head mounted wide angle camera system. Furthermore, it would be recognized that the wide angle camera system **110** may be incorporated into a headset that attaches to a user in a manner similar to that of eye-glasses and/or headbands, wherein the optical control device **100** may be incorporated into, or attached to, the eye-glasses and/or headband.

As illustrated, the optical axis **130** of the wide angle camera **115** in the wide angle camera system **110** (e.g., Google GLASS) is oriented substantially perpendicular to camera **115**. As would be appreciated the optical axis **130** is contained in a plane that is substantially perpendicular in the plane of the paper on which the drawing is shown.

In accordance with the principles of the invention, an optical lens or prism **105** incorporated into control device **100** alters the orientation of the optical axis **130** of the wide angle camera **115** to lie along the downward (with respect to the plane containing optical axis **130**) axis **140**. Axis **140** in this altered or deflected state represents an effective optical axis of the camera **115**.

Also illustrated is rotary joint **160**, which allows prism **105** to be rotated, around the optical axis **130** of camera **115**, to change the direction of axis **140** in a substantially circular direction **170**. Rotary joint **160** is used to radial change the refracted axis of prism **105** about optical axis **130** such that the optical axis **130** of the wide angle camera **115** may be changed to one of a plurality of positions along a conical section as represented by axis **140**.

Optical control device **100** further includes a frame **117** and a tab **118**, which together attach optical control device **100** to camera system **110** (e.g. via a C-clamp-type bracket configuration). Screw **119**, when tightened, retains pressure between tab **118** and frame **117** such that device **100** remains optically aligned with optical axis **130** of camera **115**. Alternatively, frame **117** may include an extension tab **111**, which attaches to a back end of camera system **110** or frame. In one aspect of the invention, tab **111** may be fixed such that device **100** may be snapped fitted onto camera system **110**. In another aspect of the invention, tab **111** may be rotatable such that tab **111** may, in one state engage the back of camera system **110** and in another state be rotated away from the back of camera system **110**. In a preferred embodiment, optical control device **100** is a removable device. Alternatively, optical control device **100** may be permanently mounted to camera system **110**.

FIG. **1**B illustrates a second aspect of the control device **100** shown in FIG. **1**A, wherein the orientation of prism **105** is changed by the rotation of the orientation of prism **105** by rotary joint **160**. In this illustrated aspect, the orientation of the optical axis **130** of the wide angle camera **115** is altered so as to lie along upward (with respect to the plane containing the optical axis **130**) axis **140'**.

In accordance with the principles of the invention, the effective optical axis **130** of camera **115** is directed along the edge of the conical shape as represented by axis **140** and axis **140'**. By rotating prism **105** radially through 360 degrees (line **170**) the refracted line of sight of the prism will sweep around a circle (line **170**) forming a conical shape around the original line of sight (i.e., optical axis **130** of camera **115**). For example, prism **105** may be rotated such that the effective optical axis **140** (**140'**) may lie within the plane containing the optical axis **130**. Similarly, the prism **105** may be rotated to achieve any angle between the axis **140** extending below the horizontal plane containing the optical axis **130** (FIG. **1**A) and the axis **140'** extending above the horizontal plane containing the optical axis **130** (FIG. **1**B) along the conical shape formed by rotation of prism **105** along line **170**.

FIG. **1**C illustrates, similar to FIG. **1**B, a second aspect of the embodiment of the invention. In this illustrated example, the field of view **192** of camera **115**, which is centered on optical axis **130**, is altered so that an altered field of view **194** of camera **115** is centered on effective optical axis **140'**. As would be appreciated, the field of view of camera **115** is determined based on the characteristics of the camera **115** and corresponding lens system. Refraction of optical axis **130** by prism **105** along the conical shape, represented by axis **140** and axis **140'**, retains substantially the original camera field of view.

FIG. **2** illustrates a side view of an application of the optical axis control device **100** attached to a wide angle camera system **110**, such as Google GLASS, wherein the optical axis **130** of the wide angle camera **115** (hidden by optical axis control device **100**) is altered or refracted to lie along the downward (with respect to the horizontal plane containing the optical axis **130**) axis **140**. In addition, the angle to which the optical axis of camera **115** is altered is such that the axis **140** intersects a task oriented point **220**. Task oriented point **220** represents a point (or area) of convergence of the altered optical axis **140** of camera **115** and an optical line of vision **212** of a user.

As would be recognized, and discussed in further detail, herein, the angle of refraction (i.e., alteration or deflection) of the optical axis **130** of camera **115** may be dependent upon the power of prism **105**. For example, prisms having a high power cause greater alteration in the optical axis **130** that prisms having lower power.

In accordance with the principles of the invention, rotating prism **105** by joint **160**, and deflecting (refracting) the optical axis **130** of camera **115** along effective optical axis **140** so as the viewing axis of camera **115** is directed to a point (e.g., task oriented point **220**) at which the user is viewing, the field of view **192** of camera **115** is able to capture (either images or video) what the user is viewing (e.g., field of view **194**) without the user adjusting his/her position to move camera **115** into a suitable position.

Although camera **115** is offset from the user's eyes, it would be recognized that, while the offset causes some degree of parallax, between the user's optical line of sight and the effective camera axis **140**, the effect of parallax is diminished as the distance of task point **220** from camera **115** increases. Similarly, the effect of parallax between the effective optical axis of camera **140** and the user's line of sight may be diminished and compensated for using known methods.

FIG. **3** illustrates a top view of the application of the optical axis control device **100** shown in FIG. **2**. In this illustrated example, optical control device **100** alters the orientation of prism **105** such that the effective optical axis **140** of camera **115** is directed toward task oriented point **220**. Task point **220** is determined based on the user's eye position, which may be represented as the intersection of the viewing axis **330** of the user's right eye and the viewing axis **330'** of the user's left eye. Thus, as the user's eyes change position the task point **220** changes and by appropriate orientation of prism **105**, the effective optical axis **140** of camera **115** may coincide with the changed position of task point **220**.

By maintaining the orientation of prism **105** such that the effective optical axis **140** of camera **115** is maintained at task point **220**, camera **115** captures and/or records images at task oriented point **220** that are being viewed by the user.

Thus, in accordance with the principles of the invention, images of the tasks being performed by a user at the task point **220** may be captured and/or recorded without the user adjusting the camera's position in order to have the effective optical axis **140** of camera **115** to coincide with, or converge onto, task point **220**.

As would be appreciated, the power and/or orientation of prism **105** may be designed for different distances of the task oriented point **220** from the user. For example, angle **215**, which is measured between the refracted image axis **140** of prism **105** and the plane of surface **216** of prism **105**, may be altered based on the power prism **105**. In one aspect of the invention, by varying the angle **215** (thus, the angle of refracted image axis **140**), the distance of task oriented point **220** from the user may be varied toward or away from the user. Thus, different prism powers may be used to accommodate different distances of task oriented point **220**.

Alternatively, the orientation of prism **105** with respect to the optical axis **130** of camera **115** (see FIG. **1**A) may be adjusted to allow, for a same power prism, task oriented points **220** to lie at different distances from the user, as will be further discussed.

FIG. **4** illustrates another exemplary application of the optical axis control device in accordance with the principles of the invention.

In this illustrative example, the wide angle camera **115** (not shown) incorporated into camera system (e.g., Google Glass) **110** that is incorporated into a surgical or dental headset **310**. Surgical or dental head set **310** includes lens **315** into which telescopic lens **320** are incorporated. Typically, telescopic lens **320** may be oriented an any angle (downward) with respect to a horizontal plane (not shown), passing through the ends of telescopic lens **320**, that is substantially parallel to the horizontal plane of optical axis **130**. While telescopic lens **320** may be oriented at any known downward angle, for the purposes of describing the invention herein, a downward angle of 25 degrees is selected as a typical downward angle.

Furthermore, as FIG. **4** illustrates a side view of the surgical or dental headset **310**, it would be appreciated that a second lens and telescopic lens **320** is not shown. The pair of telescopic lens **320** are also angularly oriented such that the line of sight of the telescopic lens **320** converge at task oriented point **220**.

Telescopic lens **320** enables a surgeon or dentist to view an enlarged image of a desired area (e.g., task point **220**). In many cases, a surgeon, for example, will operate where his working area is well below the level of his eyes and the surgeon will not necessarily tilt their head down in order to see the working area. In this situation, the surgeon may have a more horizontal head angle (e.g., in a plane parallel to the horizontal plane containing optical axis **130**) and will depend on changing his eye position in order to look down a pair of angled telescopic lens **320**, along viewing axis **330**, to effectively view the area being operated on (e.g., task point **220**). Since the surgeon's head is oriented generally horizontally, the wide angle camera **115** is not positioned to capture the operating area (task point **220**) as the optical axis **130** is oriented substantially perpendicular to the headset **310** in the plane containing optical axis **130**.

In accordance with the principles of the invention, the surgeon or dentist may orient prism **105** in optical control device **100** such that the optical axis **130** of camera **115** (not shown) is substantially coincident with effective optical axis **140** such that the field of view **194** of camera **115** is convergent upon the operating area (i.e., task oriented point **220**). In this manner, a surgeon or dentist may record a task that the surgeon or dentist is performing even if the surgeon lifts his/her eye position during the operation or surgery. Furthermore, if the surgeon lifts his/her head and changes the effective optical axis **140** of camera **115**, the correct orientation of the effective optical axis **140** may be reacquired when the surgeon returns their head/eyes to the task oriented point **220**.

As discussed previously, a parallax effect between the effective optical axis **140** and viewing axis **330** is reduced as a distance to the task point **220** increases. Similarly, at closer ranges any parallax may be minimized by appropriate compensation. Alternatively, the effect of parallax may be minimal with the utilization of a camera **115** with a wide angle field of view.

FIG. **5** illustrates a top view of the application of the optical axis control device **100** shown in FIG. **4**.

In this illustrated example, the task oriented point **220** is determined by the intersection of the viewing axis **330** of the right eye and the viewing axis **330'** of the left eye through telescopic lens **320** and **320'**, respectively. Prism **105** is rotated by joint **160** (not shown), as previously discussed, such that the optical axis **130** of camera **115** (not shown) is coincident with axis **140**, such that the effective optical axis of camera **115** is directed toward and substantially intersects task point **220**. As previously discussed, in one aspect of the invention, at least one of the power and orientation of prism **105** determines the degree of refraction and, thus, the effective optical axis **140**. In one aspect of the invention, a same task oriented point **220** may be achieved using different angles of rotation and powers of prism **105**. Similarly, the distance of the task oriented point **220** from the user may be varied based on the use of different prisms with different powers and different angles of rotation.

FIG. **6**A illustrates a right side view of the optical axis control device **100**, similar to that shown in FIG. **1**A. Device **100** includes frame **117** used to attach device **100** to a head set including a camera **115** (e.g., Google Glass), as previously discussed. Frame **117** further includes a first housing **620** connected to second housing **610**. Prism **105** is incorporated into second housing **610**. Prism **105**, as is generally known, is an optical clear glass or plastic lens that reflects light passing through it. As shown prism **105** may have a right angular configuration, wherein the base leg is attached to second housing **610** and the hypotenuse leg projects from second housing **610**. The power of prism **105** is determined by the desired angle of the task orient point **220** in relation to the line of sight of the user and the position of the camera image axis.

Second housing **610** rotates with respect first housing **620** through joint **160** and changes the orientation of optical axis of camera **115** passing through prism **105** (see FIG. 1A). As previously discussed, frame **117** in conjunction with tab **118** (or tab **111**) retains device **100** onto wide angle lens camera system **110**. Camera **115**, may itself be attached to, or incorporated within, a frame of an eyeglass or headband. Optical control device **100** is constructed such that the optical axis **130** of camera **115** is aligned, through an opening in the first housing, with prism **105**.

FIG. **6**B illustrates a front view of the optical axis control device **100**, in accordance with the principles of the invention, showing camera system **110** and second housing **610**, which includes prism **105**. Further illustrated, through prism **105**, is lens opening **611** in second housing **610**. Lens opening **611** in second housing **610** coincides with a similar lens opening **612** in first housing **620**. Lens openings **611** and **612** further coincides with, and are optically aligned to, the optical axis **130** (not shown) of camera **115**.

FIG. **6**C illustrates a left side view of the optical axis control device **100**, which is similar to the right side view shown in FIG. **6**A. In this exemplary embodiment, device **100** is shown attached to camera system **110** through a pressure asserted between tab **118** and frame **117** by screw **119**.

As further shown an outer rim of second housing **610** may be knurled or serrated to provide a roughen surface to rotate second housing **610** with respect to first housing **620**.

FIG. **6**D illustrates an exploded perspective view of control device **100** showing frame **117**, first housing **620** and second housings **610**, which includes prism **105**. Also shown is rotary joint **160** positioned on second housing **610** and engaging an interior surface of first housing **620**. As shown a groove **650** may be included in first housing **610**, which is used to guide rotation of second housing **610**.

Groove **650** of rotary joint **160** may engage a tab or a raised track (not shown) in first housing **620**, through which first housing rotates with respect to first housing **620**. The engagement of groove **650** of rotary joint **160** with tab or a raised track (not shown) in first housing **620** enables second housing **610** to rotate about an axis substantially perpendicular to the first housing **620**.

In accordance with the principles of the invention, second housing **610** may, thus, rotate substantially perpendicular to optical axis **130** of camera **115**, as previously described.

Although it has been shown that the rotary joint **160** is positioned on second housing **610**, it would also be appreciated that the rotary joint **160** may be positioned on first housing **620** without altering the scope of the invention. For example, first housing **620** may include an internal track or groove (not shown) and joint **160**, located on second housing **610**, may include a raised tab or raised track (not shown) that engages the not shown internal track or groove within first housing **620**.

Further illustrated is screw **119** used in conjunction with tab **118** to retain device **100** in a fixed relationship with the optical axis **130** of camera **115** of wide angle lens camera system **110** (e.g., Google Glass).

Also illustrated is tab stop **651** in groove **650**. Tab stop **651** limits the rotation of second housing **610** with respect to first housing **620**. Utilizing tab stop **651**, for example, limits the rotation of second housing **610** such that the refracted axis **140** of prism **105** may be limited to angles that point inward and toward task point **220** (not shown).

Although tab stop **651** allows for limited rotation of second housing **610**, it would be recognized that groove **650** may be fabricated without tab stop **651** and thus, a full 360 degree rotation of second housing with respect to first housing **620** may be achieved. Similarly if two stops **651** are incorporated into groove **660**, then rotation of second housing **610** with respect of first housing **620** is limited between the first and second tab stops **651**.

FIG. **7** illustrates a cross-sectional view of the optical axis control device **100** retained on wide angle camera system **110**. In this illustrative example, optical control device **100** is retained on wide angle camera system **110** between frame **117** and tab **118** by engagement of screw **119** (as previously described). Further illustrated is first housing **620** and second housing **610**, including prism **105**. Within first housing **620** is a tab or raised track **710**. Tab or raised track **710** engages groove **650** in second housing **610**, such that second housing **610** may rotate with respect to first housing **620**. Rotation of second housing **610** enables prism **105** to rotate with respect to optical axis **130** of camera **115**, as previously discussed.

Although FIG. **7** illustrates an example of rotary joint **160** including tab or raised track **710** in first housing **620** and groove **650** in second housing **610**, it would be appreciated that in an alternative embodiment, tab or raised track **710** may be formed in second housing **610** and groove **650** may be formed in first housing **620** without altering the scope of the invention claimed. Similarly the limiting tab **651** may be incorporated into groove **650**, which in this alternative embodiment, is contained in first housing **620**.

FIG. **8**A illustrates a perspective view of an optical control device **100** and camera system **110** attached to an eyeglass assembly **810** including telescopic lens **320**, **320'**, associated with the right and left eye, respectively. Also, shown is task point **220** at a distance of thirty (30) inches from the eyeglass assembly **810**.

For purposes of describing the inventive concept of the present invention, in this illustrative embodiment, prism **105** is selected as a 15 degree diopter prism. As would be recognized in the art, a diopter represents a measure of the deflection of light passing through a prism equal to a deflection of 1 centimeter at a distance of 1 meter. It would be recognized that prisms of other powers (i.e., diopter) may be selected without altering the scope of the invention.

As shown, with a 15 degree diopter prism, in order to focus the effective optical axis **140** at or substantially near task point **220**, with an orientation of telescopic lens **320** at a 25 degree down angle (from the horizontal plane parallel to the horizontal plane containing the optical axis **130**), prism **105** is rotated at an angle of 8.62 degree above the horizontal plane containing the optical axis **130** so as to orient the optical axis **130** of camera **115** at a down angle of 27.7 degrees. Positioning prism **105** at the illustrated down angle orients the optical axis **130** of camera **115** along the effective optical axis **140** so as to focus the field of view of camera **115** on task point **220** (formed by the intersection of the viewing lines **330**, **330'**). FIG. **8**B illustrates a perspective view of the orientation of optical device **100** similar to that shown in FIG. **8**A, wherein the task point **220** is selected to be nine (9) inches from the eyeglass **810**. In this case, the 15 degree diopter prism **105** is oriented at a down angle of 34.52 degrees by rotating prism **105** by 22.5 degrees from the horizontal plane containing the optical axis **130** in order to orient the optical axis **130** of camera **115** along effective optical axis **140**.

FIGS. **9**A and **9**B illustrate graphs of down angle and rotational angle, respectively, as a function of distance, with a

15 degree Diopter prism. FIG. **9**A illustrates, for the configuration shown in FIGS. **8**A and **8**B, the down angle required (i.e., the effective optical axis **140**) to focus camera **115** onto task point **220** varies between 42 and 28 degrees. FIG. **9**B illustrates that the rotational angle (from the horizontal plane containing the optical axis **130**) to achieve the required distance varies between 30 and 9 degrees.

Although FIGS. **9**A and **9**B illustrate the operational conditions for a particular configuration (i.e., 15 degree diopter prism and telescopic lens at 25 degrees downward angle) it would be appreciated, that either one or both of the prism power and telescopic lens orientation (or no telescopic lens at all) may be altered without altering the scope of the invention. For example, the prism power may be selected to be in a range of 5-25 degree diopter. A specific power may be determined based on the downward angle of the telescopic lens. Similarly, the prism power and the downward angle of the telescopic lens may be determined based on a desired task point distance. Such different configurations have been contemplated and are considered to be within the scope of the invention.

FIG. **10** illustrates a chart of the combination of working distance (task point **220**) and the rotational angle of prism **105** to achieve a down angle necessary to deflect the optical axis **130** of camera **115** along effective optical axis **140**. FIG. **10** illustrates rotational angles for the optical control device **100** when incorporated into an assembly having downward orientation (i.e., drill angle) of 25 degrees and a prism power of 15 degree Diopter. It would be within the knowledge of those skilled in the art to formulate combinations of working distance and rotational angles using different prism power to achieve different down angles. The use of different downward orientations and/or prism powers is considered to be within the scope of the invention claimed herein.

Returning to FIGS. **1**A and **1**B, FIGS. **1**A and **1**B illustrate a conventional configuration of a flat face of prism **105** being substantially perpendicular to the optical axis **130** of camera **115** (hidden by optical axis control device **100**), it would be appreciated that the flat face of prism **105** may be oriented offset from a perpendicular position such that the angle of refraction caused by prism **105** may be different than when prism **105** is oriented as shown in FIGS. **1**A and **1**B.

Thus, the orientation of prism within second housing **610** as being parallel to or offset from second housing **610** is also considered to be within the scope of invention.

Although not shown it would be appreciated that a locking mechanism may be utilized to lock or retain the rotational angle of prism **105** at a desired angle. For example, a screw (not shown) may be screwed through the first and second housings to in order to retain the positional relationship between the first and second housings.

The invention has been described with reference to specific embodiments. One of ordinary skill in the art, however, appreciates that various modifications and changes can be made without departing from the scope of the invention as set forth in the claims. Accordingly, the specification is to be regarded in an illustrative manner, rather than with a restrictive view, and all such modifications are intended to be included within the scope of the invention.

Benefits, other advantages, and solutions to problems have been described above with regard to specific embodiments. The benefits, advantages, and solutions to problems, and any element(s) that may cause any benefits, advantages, or solutions to occur or become more pronounced, are not to be construed as a critical, required, or an essential feature or element of any or all of the claims.

As used herein, the terms "comprises", "comprising", "includes", "including", "has", "having", or any other variation thereof, are intended to cover non-exclusive inclusions. For example, a process, method, article or apparatus that comprises a list of elements is not necessarily limited to only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. In addition, unless expressly stated to the contrary, the term "of" refers to an inclusive "or" and not to an exclusive "or". For example, a condition A or B is satisfied by any one of the following: A is true (or present) and B is false (or not present); A is false (or not present) and B is true (or present); and both A and B are true (or present).

The terms "a" or "an" as used herein are to describe elements and components of the invention. This is done for convenience to the reader and to provide a general sense of the invention. The use of these terms in the description herein should be read and understood to include one or at least one. In addition, the singular also includes the plural unless indicated to the contrary. For example, reference to a composition containing "a compound" includes one or more compounds. As used in this specification and the appended claims, the term "or" is generally employed in its sense including "and/or" unless the content clearly dictates otherwise.

All numeric values are herein assumed to be modified by the term "about," whether or not explicitly indicated. The term "about" generally refers to a range of numbers that one of skill in the art would consider equivalent to the recited value (i.e., having the same function or result). In any instances, the terms "about" may include numbers that are rounded (or lowered) to the nearest significant figure.

It is expressly intended that all combinations of those elements that perform substantially the same function in substantially the same way to achieve the same results are within the scope of the invention. Substitutions of elements from one described embodiment to another are also fully intended and contemplated.

What is claimed is:

1. An optical axis alignment device comprising:

a bracket attaching said device to a frame, said frame incorporating a camera system therein, said camera system having an optical axis projecting substantially horizontally from said camera system;

a housing comprising:

a first part fixed to a first side of said bracket; and

a second part comprising a prism refracting said optical axis of said camera system based on a power of said prism and a rotation of said prism with respect to said optical axis; and

a hinge between said first part and said second part, said hinge rotating said second part with respect to said first part.

2. The optical axis alignment device of claim **1**, wherein said first part and said second part include openings therein, said openings aligned with said optical axis.

3. The optical axis alignment device of claim **1**, wherein said bracket further comprises:

an upper part attached to a second side of said bracket; and

a lower part attached to said second side of said bracket, wherein said frame is captured between the upper part and the lower part.

4. The optical axis alignment system of claim **3**, further comprising:

a screw hole in at least one of said upper part and said lower part.

5. The optical axis alignment system of claim **3**, wherein said upper part comprising a tab engaging a back end of said frame, said tab rotatable with respect to said back end of said frame.

6. The optical axis alignment system of claim **1**, wherein said hinge comprises:

a raised track on said first part; and

a groove on said second part, said groove engaging said raised track on said first part.

7. The optical axis alignment system of claim **6**, further comprising:

at least one tab within said groove.

8. The optical axis alignment system of claim **1**, wherein said hinge comprises:

a raised track on said second part; and

a groove on said first part, said groove engaging said raised track on said second part.

9. The optical axis alignment system of claim **8**, further comprising:

at least one tab within said groove.

10. The optical axis alignment system of claim **1**, wherein said frame includes a plurality of telescopic lens, said telescopic lens oriented at a downward angle and focused at a known distance from said frame.

11. The optical axis alignment system of claim **1**, further comprising:

means for retaining said first housing in a fixed position with respect said second housing.

12. An assembly comprising:

a frame comprising:

a lens assembly; and

a camera system; and

an optical axis alignment system attached to said frame, said optical axis alignment system comprising:

a first housing containing a first opening, said first housing attached to said frame; and

a second housing comprising:

a second opening; and

a prism of a known power, wherein said first opening and said second opening are optically aligned with an optical axis of said camera system; and

a rotatable hinge between said first housing and second housing, said rotatable hinge allowing rotation of said second housing with respect to said first housing, said rotation of said second housing causing said prism to refract said optical axis of said camera system toward a desired task point.

13. The assembly of claim **12**, wherein said lens assembly comprises:

two lenses.

14. The assembly of claim **13**, wherein each of said two lenses includes a telescopic lens, said telescopic lens oriented a known down angle.

15. The assembly of claim **14**, wherein said telescopic lens are oriented toward said desired task point.

16. The assembly of claim **15** wherein orientation of said second housing with respect to said first housing is determined based on a power of said prism and said known distance.

17. The assembly of claim **12**, wherein said hinge comprising:

a raised track in said first housing; and

a groove in said second housing, said groove engaging said raised track.

18. The assembly of claim **12**, wherein said hinge comprising:

a raised track in said second housing; and

a groove in said first housing, said groove engaging said raised track.

19. An optical axis alignment device comprising:

a bracket attaching said device to a frame, said frame incorporating a camera system therein, said camera system having an optical axis projecting substantially horizontally from said camera system;

a housing comprising:

a first part fixed to a first side of said bracket; and

a second part comprising a prism; and

a hinge between said first part and said second part, said hinge rotating said second part with respect to said first part, wherein said prism deflects said optical axis of said camera system based on a power of said prism and an angle of rotation of said prism with respect to a plane containing and substantially horizontal to said optical axis.

20. The optical axis alignment device of claim **19**, wherein said prism has a power in a range of 5-25 degree diopters.

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